

SEC Petition Evaluation Report

Petition SEC-00060

Report Rev # 08-04-06

Report Submittal Date _____

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Site Expert(s):

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Petitioner Administrative Summary

Petition Under Evaluation

Petition #			Petition Type		Petition A Submittal Date		DOE/AWE Facility Name				
SEC-00060			83.14		05/30/2006		S-50 Oak Ridge Thermal Diffusion Plant				
Feasible to Estimate Doses with Sufficient Accuracy?											
Single Class				Multiple Classes				Determination Established for All Classes			
Yes		No	X	Yes		No	X	Yes	X	No	

Proposed Class Definition

All employees of the Department of Energy (DOE) predecessor agencies, and their contractors and subcontractors, who were monitored or should have been monitored for exposure to ionizing radiation while working at the S-50 Oak Ridge Thermal Diffusion Plant for a number of work days aggregating at least 250 work days from July 9, 1944, through December 31, 1951, or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

Related Petition Summary Information

SEC Petition Tracking #(s)	Petition Type	DOE/AWE Facility Name	Petition Status
None			

Related Evaluation Report Information

Report Title	DOE/AWE Facility Name
None	

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Evaluation Report Summary: SEC-00060 S-50 Oak Ridge Thermal Diffusion Plant

This evaluation report by the National Institute for Occupational Safety and Health (NIOSH) addresses a class of employees proposed for addition to the Special Exposure Cohort (SEC) per the *Energy Employees Occupational Illness Compensation Program Act of 2000*, as amended, 42 U.S.C. § 7384 *et seq.* (EEOICPA), and 42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*.

NIOSH Proposed Class Definition

The NIOSH-proposed class includes all employees of the Department of Energy (DOE) predecessor agencies, and their contractors and subcontractors, who were monitored or should have been monitored while working at the S-50 Oak Ridge Thermal Diffusion Plant for a number of work days aggregating at least 250 work days from July 9, 1944, through December 31, 1951, or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

Feasibility of Dose Reconstruction

Per EEOICPA and 42 C.F.R. § 83.14(b), NIOSH has established that it does not have sufficient information to complete dose reconstructions for individual members of the class with sufficient accuracy.

Health Endangerment Determination

The NIOSH evaluation did not identify evidence from the petitioners or from other sources that would establish that the class was exposed to radiation during a discrete incident likely to have involved exceptionally high-level exposures. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated substantial chronic radiation exposures through intakes of radionuclides and from direct exposure to radioactive materials. Therefore, the regulation [42 C.F.R. § 83.13(c)(3)(ii)] requires NIOSH to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

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SEC Petition Evaluation Report for SEC-00060

1.0 Purpose and Scope

This report evaluates the feasibility of reconstructing doses for employees who worked at a specific facility during a specified time. It provides information and analysis germane to considering a petition for adding a class of employees to the congressionally-created SEC.

This report does not provide any determinations concerning the feasibility of dose reconstruction that necessarily apply to any individual energy employee who might require a dose reconstruction from NIOSH, with the exception of the employee whose dose reconstruction could not be completed led to this petition evaluation. The finding in this report is not the final determination as to whether or not the proposed class will be added to the SEC. This report will be considered by the Advisory Board on Radiation and Worker Health (the Board) and by the Secretary of Health and Human Services (HHS). The Secretary of HHS will make final decisions concerning whether or not to add one or more classes to the SEC in response to the petition addressed by this report.

This evaluation, in which NIOSH provides its findings on the feasibility of estimating radiation doses of members of this class with sufficient accuracy and on health endangerment, was conducted in accordance with the requirements of EEOICPA and 42 C.F.R. § 83.14.

2.0 Introduction

Both EEOICPA and 42 C.F.R pt. 83 require NIOSH to evaluate qualified petitions requesting the Department of Health and Human Services to add a class of employees to the SEC. The evaluation is intended to provide a fair, science-based determination of whether or not it is feasible to estimate, with sufficient accuracy, the radiation doses of the class of employees through NIOSH dose reconstructions.¹

NIOSH is required to document its evaluation in a report. In doing so, NIOSH relies on its own dose reconstruction expertise as well as technical support from Oak Ridge Associated Universities (ORAU). Upon completion, the report is provided to the petitioners and to the Advisory Board on Radiation and Worker Health. The Board will consider the NIOSH evaluation report, together with the petition, comments of the petitioner(s) and such other information as the Board considers appropriate, to make recommendations to the Secretary of HHS on whether or not to add one or more classes of employees to the SEC. Once NIOSH has received and considered the advice of the Board, the Director of NIOSH will propose decisions on behalf of HHS. The Secretary of HHS will make final decisions, taking into account the NIOSH evaluation, the advice of the Board, and the proposed

¹ NIOSH dose reconstructions under EEOICPA are performed using the methods promulgated under 42 CFR 82 and the detailed implementation guidelines available at www.cdc.gov/niosh/ocas.

decision issued by NIOSH. As part of this final decision process, the petitioner(s) may seek a review of certain types of final decisions issued by the Secretary of HHS.²

3.0 NIOSH Proposed Class Definition and Petition Basis

This NIOSH report provides a summary of the methods and findings of the NIOSH SEC evaluation for employees of DOE predecessor agencies, and their contractors and subcontractors, who were monitored or should have been monitored for exposure to ionizing radiation while working at the S-50 Oak Ridge Thermal Diffusion Plant for a number of work days aggregating at least 250 work days from July 9, 1944, through December 31, 1951, or in combination with work days within the parameters established for one or more other classes of employees in the SEC. This class definition includes the entire covered period for the S-50 Site. During this period, employees at this facility were either involved with uranium enrichment operations using the liquid thermal diffusion process, or they participated in activities associated with the Nuclear Energy for the Propulsion of Aircraft (NEPA) project.

The evaluation responds to Petition SEC-00060, submitted by an EEOICPA claimant employed at the S-50 Site as a design engineer for the NEPA project during this period, whose dose reconstruction could not be completed by NIOSH because of a lack of sufficient dosimetry-related information. The determination by NIOSH that it is unable to complete a dose reconstruction for a EEOICPA claimant is a qualified basis for submitting an SEC petition pursuant to 42 C.F.R. § 83.9(b).

4.0 Radiological Operations Relevant to the Proposed Class

The following subsections summarize the radiological operations at the S-50 Site from July, 1944, through December, 1951, and the information available to NIOSH to characterize particular processes and radioactive source materials. From available sources, NIOSH has gathered process and source descriptions, information regarding the identity and quantities of certain radionuclides, and information describing some of the processes through which the radiation exposures of concern may have occurred and the physical environment in which they may have occurred. The information included within this evaluation report is meant only to be a summary of the available information.

4.1 S-50 Liquid Thermal Diffusion Plant

The S-50 Liquid Thermal Diffusion Plant was a wartime uranium enrichment facility constructed in 1944 by H. K. Ferguson Company and operated by Fercleve Corporation, a fully-owned subsidiary of H. K. Ferguson Company that was organized for the sole purpose of operating the S-50 plant. Ground-breaking for the facility was on July 9, 1944, and construction was completed on October 31, 1944. Uranium enrichment began on September 16, 1944, before construction was complete. Thermal diffusion operations shut down on September 9, 1945. (S-50, 2005)

² See 42 C.F.R. pt. 83 for a full description of the procedures summarized here. Additional internal procedures are available at www.cdc.gov/niosh/ocas.

There was a tremendous amount of emphasis placed on high production output at this facility. Processed uranium from the plant was used as feed material for the Y-12 facility where it was further enriched and eventually used in the bomb dropped over Hiroshima ("Little Boy"). Operations at S-50 generally continued around the clock. The number of individuals employed by the Fercleve Corporation reached a maximum of over 1500 individuals in April, 1945 (Manhattan, 1947).

The process to enrich uranium at S-50 consisted of multiple columns, with each column containing three concentric pipes. High-pressure (1000 psig) steam was passed through the innermost nickel pipe, which was inside a copper pipe. Uranium hexafluoride (UF_6) was batch-charged into the gap between the nickel and copper pipes at about 1500 psig. The nickel and copper pipes were located inside the outermost steel pipe. Cold water was passed between the steel pipe and the outer wall of the copper pipe. The enrichment process utilized convective flow, whereby the lighter $^{235}\text{UF}_6$ molecules tended to move upward along the hot nickel pipe wall, while the heavier $^{238}\text{UF}_6$ molecules moved downward along the cold copper wall (Manhattan, 1947).

Losses of UF_6 were common during S-50 operations, with UF_6 often escaping into the air or cooling water (Manhattan, 1947). The losses usually resulted from internal or external breaks in columns or other parts of the process, which were caused by failure of the materials under the high operating pressures. Other losses resulted from improper handling of open connections, and from various operational mistakes, due in part to the number of new employees at the facility and the emphasis on high operational production. From March through July, 1945, monthly losses of UF_6 ranged from 247 to 1826 pounds (S-50, 2005). Accountability records showing losses for other months of operation are unavailable. The released UF_6 would rapidly oxidize and form UO_2F_2 , which would either be exhausted through the building roof or settle to the process building floor. Operators were required to have a gas mask on their persons at all times for emergencies (Manhattan, 1947).

The S-50 plant ceased enrichment operation in September, 1945, shortly after the war ended. The uranium enrichment process utilized at S-50 was unique in that it was the only production-scale liquid thermal diffusion facility ever built. S-50 closed because it had become evident that the liquid thermal diffusion process would not be competitive with the gaseous diffusion process.

Disassembly of the S-50 process equipment was done in the late 1940s, at which time it was removed from the main process building and transported to the K-25 Powerhouse Area where it was stored for some period of time before being either salvaged or buried (S-50, 2005).

4.2 S-50 Site Nuclear Energy for the Propulsion of Aircraft (NEPA) Project

From May 1, 1946, through December 31, 1951, the S-50 facilities were used to conduct feasibility studies for the Nuclear Energy for the Propulsion of Aircraft (NEPA) project. The NEPA operations were conducted by Fairchild Engine and Aircraft Corporation. The NIOSH Site Research Database (SRDB) and Internet searches yielded no data describing specific NEPA-related activities or the radiological conditions of the buildings occupied during these post-1945 operations.

However, some information was obtained through the telephone interviews associated with S-50 claimants and one follow-up interview with a surviving S-50 claimant (S-50, Int75). It was learned from these interviews that S-50 employees fabricated blocks containing enriched uranium and graphite as potential fuel for a nuclear-powered airplane. They also recovered enriched uranium using

nitric acid solutions. The recovered enriched uranium was then used to fabricate the uranium and graphite blocks. One interviewee stated that “the place was highly radioactive given the enriched U-235 they were handling.” According to documented interviews from other claimants, activation analysis studies may also have taken place at S-50 on items that were previously irradiated at X-10. Employees during this time period may also have been exposed to contamination remaining from the prior liquid thermal diffusion projects in this facility (NIOSH has no records documenting decontamination of the facility at the conclusion of those operations).

5.0 Summary of Available Monitoring Data for the Proposed Class

The primary data for determining internal exposures are personal monitoring data such as urinalyses, fecal samples, and whole-body counting results. If these data are unavailable, air monitoring data from breathing zone area and general area monitoring are used to estimate the potential internal exposure. If personal monitoring and breathing zone area monitoring are unavailable, internal exposures can sometimes be estimated or bounded using more general area monitoring, process information, and information characterizing and quantifying the source term.

The same hierarchy is used for determining the external exposures to the cancer site. Personal monitoring data from film badges or thermoluminescent dosimeters (TLDs) are the primary data used for determining external exposures to the cancer site. If there are no personal monitoring data, exposure rate surveys, process information, and source term modeling can sometimes be used to reconstruct or bound the potential exposure.

A more detailed discussion of the information required for dose reconstruction can be found in OCAS-IG-001, *Internal Dose Reconstruction Implementation Guide*, and OCAS-IG-002, *External Dose Reconstruction Implementation Guide*. These documents are available at: <http://www.cdc.gov/niosh/ocas/ocasdose.html>.

5.1 S-50 Site Internal Personnel Monitoring Data

Internal personnel monitoring data for the S-50 Site are not available to NIOSH. For the 21 S-50 energy employees for whom the NIOSH OCAS Claims Tracking System (NOCTS) DOE personnel monitoring records were examined, no internal dosimetry monitoring results were found specific to S-50. The available documents in the Site Research Database (SRDB) contained no evidence of any internal personnel monitoring that can be attributed to S-50 Site operations. This apparent lack of internal dose monitoring applies to the thermal diffusion operations through 1945 and to the subsequent NEPA activities.

5.2 S-50 Site External Personnel Monitoring Data

External personnel monitoring data for the S-50 Site are also not available to NIOSH. For the 21 S-50 energy employees for whom the NOCTS DOE personnel monitoring records were examined, no external dosimetry monitoring results were found specific to S-50. The available documents in the SRDB showed no evidence of any external personnel monitoring that can be attributed to S-50 Site

operations. This apparent lack of external dose monitoring applies to the thermal diffusion operations through 1945 and to the subsequent NEPA activities.

5.3 S-50 Site Workplace Monitoring Data

NIOSH has not located any air monitoring data that is known to be associated with operations at S-50.

Periodic beta-gamma radiation surveys were conducted in the facility on an approximate weekly basis during operations. These survey data are generally available and reported radiation levels to be less than 0.01 R per 8 hours. The maximum reported level in the available documentation was 0.74 R per 8 hours (Fercleve, 1945). The acceptable "tolerance level" during that time period was stated as 0.1 R per 8 hours.

Contamination surveys conducted periodically (approximately weekly) during operations indicated general area fixed plus removable contamination to be typically in the several hundred cpm/cm² (alpha) range, although several measurements were in excess of 2000 cpm/cm². Coveralls were periodically monitored for contamination, with levels typically being less than 20 cpm/cm² (alpha), although they were occasionally reported to be over 100 cpm/cm² (Fercleve, 1945).

NIOSH has been able to obtain only limited source term information for the liquid thermal diffusion operations and NEPA activities at S-50. This information is discussed in Section 4.0.

6.0 Feasibility of Dose Reconstruction for the Proposed Class

In the case of a petition submitted to NIOSH under 42 C.F.R. § 83.9(b), NIOSH has already determined that a dose reconstruction cannot be completed for an employee at the DOE or AWE facility. This determination by NIOSH provides the basis for the petition by the affected claimant. NIOSH further considered defining the extent of the class of employees who were similarly affected, as indicated by the completed research, and found that dose reconstruction is similarly not feasible.

In accordance with 42 C.F.R. § 83.14(a), NIOSH also considered whether or not the completed research provides a basis for evaluating an additional class at the facility for whom it might appear to NIOSH that dose reconstruction is unlikely to be feasible. If NIOSH were to identify such a basis, it would institute a separate SEC evaluation to conduct necessary research on the additional class. This would allow NIOSH, the Board, and HHS to complete without delay their consideration of the class, including a claimant for whom NIOSH has already determined a dose reconstruction cannot be completed, and hence, whose only possible remedy under EEOICPA would be through the addition of a class of employees to the SEC.

This section of this report summarizes research findings in which NIOSH determined that it lacked sufficient information to complete the relevant dose reconstruction and on which basis it has defined the class of employees for which dose reconstruction is not feasible. The determination relies on the same statutory and regulatory criteria that govern consideration of all SEC petitions.

6.1 Feasibility of Estimating Internal Exposures

Facility records indicate repeated releases of uranium product to the S-50 workplace during thermal diffusion operations. As discussed in Section 5.0, the only facility data related to these exposures are data from periodic surface contamination surveys conducted during operations. NIOSH was unable to obtain any internal monitoring data, air monitoring data, or source term information associated with these releases. It is not possible to determine if these surface contamination survey data adequately correlate with airborne concentrations in the workplace during these off-normal occurrences. The contamination survey data are not considered sufficient to bound or estimate more accurately the doses of employees involved in the thermal diffusion operations.

As discussed in Section 4.1, the S-50 site was the only production facility of its kind that was ever built. Because the S-50 process was unique, data from other uranium enrichment facilities cannot be used to develop internal exposure models for this facility.

In some cases, employees involved in the liquid thermal diffusion operations at the S-50 Plant may also have worked at other sites (particularly in later years) where internal dosimetry records may be available. For these cases, it might be possible to use the internal dosimetry data from these other facilities on these individuals to bound their uranium intakes from their prior employment at the S-50 Plant. This procedure would not, however, provide a means to bound the internal doses of all members of the class of employees involved in the liquid thermal diffusion operations since there would be no way of knowing whether the individuals who have such further employment and dosimetry were the most highly-exposed S-50 workers. Consequently, NIOSH lacks sufficient information to estimate with sufficient accuracy the radiation doses of employees involved in the liquid thermal diffusion operations at the S-50 Plant from July 9, 1944, through April 30, 1946.

As discussed in Section 5.0, for the period of NEPA operations at S-50 (May 1, 1946, through December 31, 1951), NIOSH has been unable to obtain sufficient data to identify and characterize any associated radiation exposures, other than potential residual contamination from the prior liquid thermal diffusion operations. Consequently, NIOSH lacks sufficient information to estimate with sufficient accuracy the radiation doses of employees involved in NEPA operations at S-50 for the specified period.

6.2 Feasibility of Estimating External Exposures

There are no external dosimetry data available for workers at the S-50 site during the time period from July 9, 1944, through December 31, 1951. Facility records indicate repeated releases of uranium product to the S-50 workplace during thermal diffusion operations. It is not possible to determine if the radiation level data available for S-50 adequately represents the workplace dose rates during these off-normal occurrences.

As discussed in Section 4.1, the S-50 Plant was the only production facility of its kind that was ever built. Because the S-50 process was unique, data from other uranium enrichment facilities cannot be used to develop external exposure models for this facility. Because the radiation levels associated with these releases cannot be determined, and because there are no associated personnel external monitoring results found, it is not possible to effectively establish an upper bound for external exposure due to the thermal diffusion operations from July 9, 1944, through April 30, 1946. For the

same reasons, the adequate reconstruction of external ambient doses at the S-50 site is also considered infeasible.

For the time period of S-50 NEPA operations from May 1, 1946, through December 31, 1951, there are insufficient data with regard to radiation sources and survey data for dose reconstruction. The adequate reconstruction of external doses at S-50 is therefore considered infeasible during the NEPA time period.

Adequate reconstruction of medical dose for S-50 workers is possible by using claimant-favorable assumptions found in the Technical Basis Documents (TBDs) for the other Oak Ridge facilities (ORAUT-TKBS-0009 [K-25]; ORAUT-TKBS-0012 [X-10]; ORAUT-TKBS-0014 [Y-12]), and by using applicable protocols specified in the complex-wide Technical Information Bulletin for dose reconstruction from occupationally-related diagnostic X-ray procedures (ORAUT-OTIB-0006).

7.0 Summary of Feasibility Findings for Petition SEC-00060

This report evaluated the feasibility for estimating the dose, with sufficient accuracy, for all workers at the S-50 Site from July 9, 1944, through December 31, 1951. NIOSH determined that it lacks internal and external personnel dosimetry data and other workplace monitoring data necessary to reconstruct the internal and external exposures to uranium compounds and other unknown radioactive materials that may have been present at the facility during this time period. Consequently, NIOSH finds that it is not feasible to estimate with sufficient accuracy the radiation doses resulting from internal or external exposures received by members of this class of employees.

NIOSH has documented in this evaluation that it cannot complete the dose reconstruction related to this petition. The basis of this finding is specified in this report, which demonstrates that NIOSH does not have access to sufficient information to estimate either the maximum radiation dose incurred by any member of the class or to estimate such radiation doses more precisely than a maximum dose estimate. Members of this class at the S-50 Site may have received radiation exposures from uranium compounds and other unknown radioactive materials that may have been present at the plant. NIOSH lacks sufficient information, which includes internal and external personnel dosimetry data and other workplace monitoring data, or sufficient process and radiological source information that would allow NIOSH to estimate the potential internal and external radiation exposures to which the proposed class may have been exposed. The adequate reconstruction of occupational medical doses at the S-50 site is considered feasible.

8.0 Evaluation of Health Endangerment for Petition SEC-00060

The health endangerment determination for the class of employees covered by this evaluation report is governed by EEOICPA and 42 C.F.R. §§ 83.14(c) and 83.13(c)(3). Pursuant to these requirements, if it is not feasible to estimate with sufficient accuracy radiation doses for members of the class, NIOSH must determine that there is a reasonable likelihood that such radiation doses may have endangered the health of members of the class. The regulation requires NIOSH to assume that any duration of unprotected exposure may have endangered the health of members of a class when it has been

established that the class may have been exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. If the occurrence of such an exceptionally high-level exposure has not been established, then NIOSH is required to specify that health was endangered for those workers who were employed for a number of work days aggregating at least 250 work days within the parameters established for the class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

NIOSH has determined that members of the class were not exposed to radiation during a discrete incident likely to have involved levels of exposure similarly high to those occurring during nuclear criticality incidents. However, the evidence reviewed in this evaluation indicates that some workers in the class may have accumulated substantial chronic radiation exposures through episodic intake of radionuclides and from direct exposure to radioactive materials. Consequently, NIOSH is specifying that health was endangered for those workers covered by this evaluation who were employed for a number of work days aggregating at least 250 work days within the parameters established for this class or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

9.0 NIOSH Proposed Class for Petition SEC-00060

The evaluation defines a single class of employees for which NIOSH cannot estimate radiation doses with sufficient accuracy. This class includes all employees of the Department of Energy (DOE) predecessor agencies, and their contractors and subcontractors, who were monitored or should have been monitored while working at the S-50 Oak Ridge Thermal Diffusion Plant for a number of work days aggregating at least 250 work days from July 9, 1944, through December 31, 1951, or in combination with work days within the parameters established for one or more other classes of employees in the SEC.

10.0 References

42 C.F.R. pt. 81, *Guidelines for Determining the Probability of Causation Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule, Federal Register/Vol. 67, No. 85/Thursday, p 22,296; May 2, 2002

42 C.F.R. pt. 82, *Methods for Radiation Dose Reconstruction Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule; May 2, 2002; SRDB Ref ID: 1939

42 C.F.R. pt. 83, *Procedures for Designating Classes of Employees as Members of the Special Exposure Cohort Under the Energy Employees Occupational Illness Compensation Program Act of 2000*; Final Rule; May 28, 2004

42 U.S.C. §§ 7384-7385 [EEOICPA], *Energy Employees Occupational Illness Compensation Program Act of 2000*; as amended

Fercleve, 1945, *Fercleve Health Survey Report* (June 1945 – September 1945); SRDB Ref ID: 5005

Manhattan 1947, *Manhattan District History Book VI Liquid Thermal Diffusion (S-50) Project*; May 21, 1947; SRDB Ref ID: 8623

OCAS-IG-001, *Internal Dose Reconstruction Implementation Guide*, NIOSH, Office of Compensation Analysis and Support (OCAS); Rev. 1; August, 2002

OCAS-IG-002, *External Dose Reconstruction Implementation Guide*, NIOSH, Office of Compensation Analysis and Support (OCAS); Rev. 0; August, 2002

ORAUT-OTIB-0006, *Dose Reconstruction from Occupationally Related Diagnostic X-ray Procedures*, Rev. 03 PC-1; December 21, 2005

ORAUT-TKBS-0009 (-1 through -6), Technical Basis Documents for the K-25 Site; various revisions and effective dates

ORAUT-TKBS-0012 (-1 through -6), Technical Basis Documents for the X-10 Site (Oak Ridge National Laboratory); various revisions and effective dates

ORAUT-TKBS-0014 (-1 through -6), Technical Basis Documents for the Y-12 Site; various revisions and effective dates

S-50, 2005, *Compilation of Historical Document Reference Sources for Project S-50, Liquid Thermal Diffusion Plant*; R. P. Prince, EMEF Inactive Records Center; U.S. DOE; May, 2005; SRDB Ref ID: 17169

S-50, Int75, Interview with S-50 Claimant, SECIS Non-Submitter Communication ID: 75; July 28, 2006